A Prospective Study of

FUNCTIONAL OUTCOME OF DISPLACED MIDDLE THIRD CLAVICULAR FRACTURES TREATED BY PLATE OSTEOSYNTHESIS.

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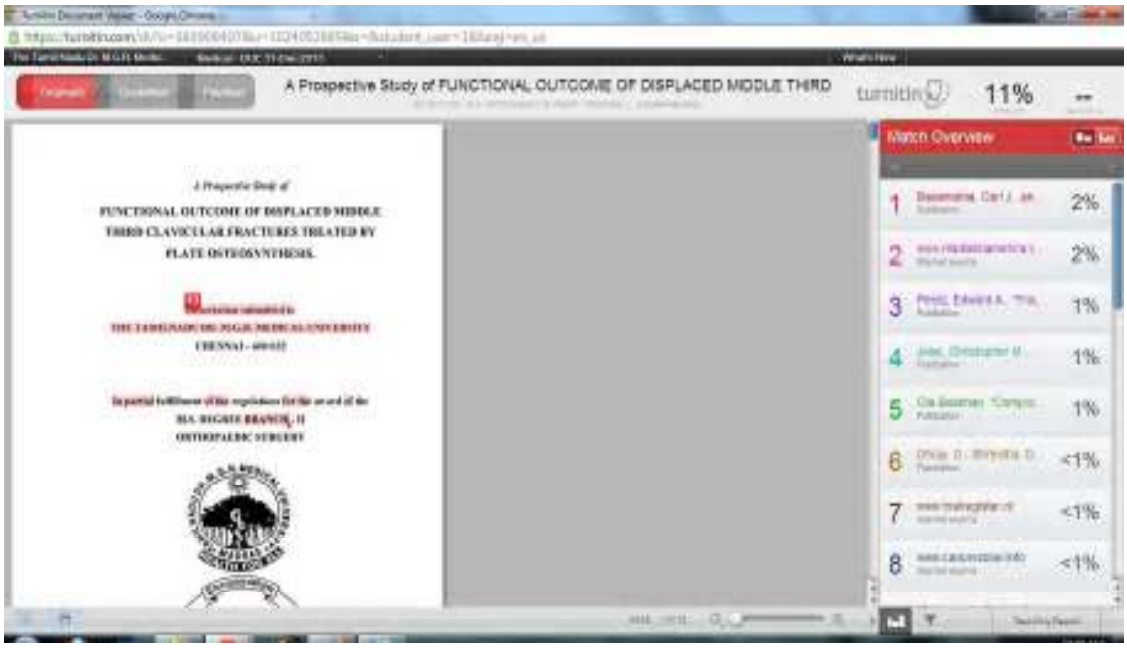
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This is to certify that Dr.PRASOBH. C, Postgraduate student (2011-2014) in the department of Orthopaedics, Government Mohan Kumaramangalam Medical College, Salem has done this dissertation "*A Prospective Study of* **FUNCTIONAL OUTCOME OF DISPLACED MIDDLE THIRD CLAVICULAR FRACTURES TREATED BY PLATE OSTEOSYNTHESIS**"under my supervision in partial fulfillment of the regulation laid down by the Tamilnadu Dr. M.G.R Medical University, Chennai for M.S. (Orthopaedics) degree examination to be held during April 2014.

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DECLARATION

I, Dr. PRASOBH. C, solemnly declare that this dissertation titled **"FUNCTIONAL OUTCOME OF DISPLACED MIDDLE THIRD CLAVICULAR FRACTURES TREATED BY PLATE OSTEOSYNTHESIS"** is a bonafide work done by me, at Government Mohan Kumaramangalam Medical College, Salem between the period 2011-2013, under the guidance of my unit Chief **Prof. Dr. C. KAMALANATHAN M.S.(Ortho)**, Professor of Orthopaedic Surgery. This dissertation is submitted to Tamilnadu Dr. M.G.R Medical University, towards partial fulfillment of regulation for the award of M.S. Degree (Branch – II) in Orthopaedic Surgery.

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CONTENTS

A Prospective Study of

FUNCTIONAL OUTCOME OF DISPLACED MIDDLE THIRD CLAVICULAR FRACTURES TREATED BY PLATE OSTEOSYNTHESIS.

Author: Dr . Prasobh

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ABSTRACT

Introduction:

Clavicle is the bony link from thorax to shoulder girdle and contributes to movements at shoulder girdle. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position. Recent studies have showed a higher rate of nonunion and shoulder dysfunction in subgroups of patients with clavicle fractures. The purpose of the study is to prospectively analyze the functional outcome of mid third displaced clavicular fractures treated by open reduction and internal fixation with plate osteosynthesis.

Materials and methods:

Thirty four cases of middle third displaced (Robinson type 2b1 and 2b2) clavicular fractures are treated with plateosteosynthesis. We used Reconstruction plate, Locking compression plate and 1/3rd tubular plate for study. Out of 34 cases 29 were males and 5 females. Right side clavicle involved more than left side. The primary outcome measures are functional constant score and radiological union time. The clinical and radiological assessments were performed at every 2nd week till 3rd month. The secondary outcome measures include per operative data (mean surgery time, blood loss), type of fracture based on mode and mechanism of injury and the complication rates.

Result:

The mean time to union was 9.5 weeks. At the latest follow up, the entire patients returned to the pre-injury activity level. Implant failure occurred in one patient in whom 1/3rd tubular plate was used. It was mal united and the patient has good functional outcome. The mean constant score was 94.14. Four

patients complained of hard ware irritation. Implant removed in two patients and there is no re fracture. One case had superficial infection which was treated with intravenous antibiotics. There is no difference between Reconstruction group and Locking compression plate group in terms of functional outcome and union rate. We also noticed that Road traffic accident and direct injury to the shoulder causes Robinson type 2b2 fractures.

Conclusion:

Open reduction and rigid internal fixation of displaced midshaft clavicular fracture has resulted in good fracture union rate and excellent functional outcome.

Key words:

Clavicle, Middle third, Displaced, Fractures, Reconstruction plate, Locking compression plate, Functional outcome.

INTRODUCTION

Clavicle is the bony link from thorax to shoulder girdle and contributes to movements at shoulder girdle. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position. It is caused by either low-energy or high-energy impact.

The traditional view that most of the clavicular fractures heal with good functional outcomes following non operative treatment is no longer valid. Recent studies have showed a higher rate of nonunion and shoulder dysfunction in subgroups of patients with clavicle fractures. Because of this, these fractures should therefore be considered as a spectrum of injuries with various functional outcomes, each requiring cautious assessment and individualized care[5].

Fracture of the clavicle is common, accounting for 5 to 12% of all fractures. About 80 to 85% of these fractures are in the middle third of the bone, where the typical compressive forces applied to the shoulder and the narrow cross section of the bone combines and result in bony failure[27].

Displaced mid shaft clavicle fractures are common and are generally treated non-operatively. Non-operative treatment of these fractures with axial shortening is associated with non union, delayed union, and mal union. Other complications are severe pain, neurological complications, loss of shoulder function and protuberant callus forming swelling and stretching of skin which is cosmetically unacceptable.

The proponents of early fixation of fresh clavicular fractures to prevent complications like mal union and nonunion emphasize the value of accurate reduction and rigid fixation in affording quick pain relief and promoting early functional recovery.

Persons with high activity level will hesitate to accept prolonged recovery and impaired shoulder function, therefore may require more aggressive treatment of middle third clavicle fractures. Prompt fixation of these clavicle fractures permits increased patient comfort, and early shoulder mobility. In cases of associated scapula fractures, fixation of the clavicle provides restoration of shoulder mechanics leading to improvement of function.

Operative treatment of displaced mid shaft clavicular fractures can be achieved successfully using plates or intramedullary implants like rush pins, kirshner wires or nails. Open reduction and internal fixation with

plating provides rigid fixation, early functional recovery and low rates of non union, mal union.

The purpose of the study is to prospectively analyze the functional outcome of mid third displaced clavicular fractures treated by open reduction and internal fixation with plate osteosynthesis.

AIM OF THE STUDY

FUNCTIONAL OUTCOME OF DISPLACED MIDDLE THIRD CLAVICULAR FRACTURES TREATED BY PLATE OSTEOSYNTHESIS.

HISTORY

1600BC **EDWIN SMITH PAPYRUS** gave earliest description of accepted method of fracture reduction[26].

400 BC **HIPPOCRATES** recorded several observations about clavicular fractures.

1700AD **PAUL OF AEGINA** wrote about treatment in supine position and application of essences.

1702 **WILLIAM III** died of complicated clavicle fracture[28].

1850 **SIR ROBERT PEEL** died of complicated clavicle fracture

1839 **DUPYTREN** treated clavicle fracture

1860 **LUCAS CHAMPIONNIERE** used figure of eight dressing.

1871 **SAYRE** used rigid dressing to reduce clavicle fracture

1913 **FAWCETT J** described ossification and development of clavicle.

1926 **QUENSA** described special x-ray views.

1931 **STANDFORD** described the moro reflex as a diagnostic aid in fracture clavicle in the newborn.

1951 **MOORE T** introduced internal pin fixation for the clavicle fractures.

1954 **ABBOT LC** and **LUCAS DB** described function of clavicle and its surgical significance

1954 **COOK. T.W** described external fixation for infected clavicle fractures.

1960 **NEER** described nonunion of fracture clavicle

1967 **ALLMAN F**[33, 34] devised first classification of clavicular fractures.

1968 **GARDNER E** described embryology of clavicle

1968 **NEER** described fractures of distal third clavicle fractures.

1976 **JIT** and **KULKARNI** analysed the appearance and fusion of epiphysis at medial end of clavicle in Indians.

1978 **KHAN MAA** and **LUCAS HK** advocated plating for middle third clavicle fractures.

1979 **LJUNGGREN**[36] described clavicular function

1982 **ROCKWOOD CA** compared fractures of the outer clavicle in children and adults.

1986 **ESKOLA**[37] evaluated surgery for nonunion fracture clavicle with grafting.

1987 **ANDERSONK** and **JENSEN P**[38] concluded that treatment of clavicle fractures with simple sling and figure of eight bandage gave equal results.

1987 **BASOM WC**; and **HERZ JR**[39] introduced dual grafts for non union clavicle fracture.

1988 **JUPITER JB** and **LIPTONHA** described shortcomings of conservative management of clavicular fractures.

1989 **KNUDSEN FW** and **KRAG** [40, 41] extensively described blood supply of clavicle.

1990 **CRAIG EV** classified clavicle fractures.

1991 **CURTISRJ** and **BOEHEME D** used modified Haige pins for non union clavicle fracture.

1992 **SCHWARZ N** and **HOCKER K**[42] recommended osteosynthesis with 2.7 mm ASIF plates in irreducible fractures.

1992 **EBERLE C** invented Balser plate.

1994 **HACKENBOUCH W** and **SCHWYZER K**[43] introduced clavicular hook plate for lateral clavicular fractures.

1994 **MULLAJI AB** and **JUPITER J**[44] LCDCP plating for clavicle fractures.

1997 **HILL JM** and **CROSSY LA** concluded that closed treatment of displaced middle third clavicle fractures gives poor results.

1998 **ROBINSON CM** described epidemiology and classification of clavicle fractures.

1999 **CANNADA** and **ALLEN** operative fixation of clavicle fractures gives good results.

2001 **WICKM** found that shortening of clavicle fracture more than 2 cm predispose to non union.

2002 **SORKIN** and **KLDEN** used antero-inferior plating for clavicular fracture non union.

2003 **MCKEE**, and **WILD LM** found that mid-shaft mal union decreases shoulder function

2004 **CHARLES M COURT BROWN** and **MC QUEEN** estimated the risk of nonunion following non operative treatment of a clavicular fracture.

2006 **MCKEE** and **JONES** analysed functional deficits of shoulder after conservative treatment of fracture clavicle.

2008 **SAHAL and MICHAEL** compared plate fixation of m/3 clavicular fractures with non operative treatment.

2009 **KHASHIF KHAN and M. ROBINSON** concluded that it provide immediate rigid stabilization and early mobilization

2012 **ROBBIN Mc KEE** analysed Operative verses non operative treatment of m/3 clavicular fractures.

2012 **KAISA J VIRTANEN** analyzed sling versus plate osteosynthesis for the treatment of m/3 clavicular fractures.

2013 **ANDREW H SCHMIDT** analysed on risk factors of nonunion after displaced m/3 clavicular fractures

2013 **I.R. MURRAY**, BMedSci Risk Factors for Nonunion after nonoperative treatment of displaced mid shaft fractures of the clavicle[47], Jbjs july 2013

ANATOMY[24, 25]

The clavicle or collar bone is introduced as one of the bones of shoulder girdle in man and in those in mammals who used their upper limbs for prehension. It has no homologue in pelvic girdle. The clavicle possesses the following functions:

(a) It acts as a strut to place the scapula laterally, so that the upper limb can swing clearly from side of trunk.

(b) It transmits the forces from the upper limb through the coraco clavicular ligament and medial thirds of the bone to axial skeleton.

(c) Concave posterior surface of the medial two thirds of the clavicle protects the neuro vascular structures of the root of the neck.

(d) It helps in various scapular movements and performs axial rotation around its long axis during elevation of arm above the head.

PECULIARITIES:

(1) The clavicle is a modified long bone, specially its medial two thirds, because it transmits the forces or weight from the upper

limb to the axial skeleton. This is however, an exception violating the following principles of long bone:

(a) It possesses no medullary cavity;

(b) Ossifies in membrane;

(c) It is sometimes pierced by cutaneous (supra clavicular) nerve.

(2) It is the first bone to start ossification in the 5^{th} or 6^{th} week of intrauterine life, and the last bone to complete ossification usually after 21^{st} year.

(3) It is horizontally placed and is subcutaneous as well as sub platysmal, because it is covered by a sheet of platysma bundle. Therefore the skin glides freely over the clavicle and fracture of the bone does not usually penetrate the skin to make the fracture compound.

PRESENTING PARTS:

The clavicle presents two ends, sternal and acromial, and a shaft which is curved with the convexity in front in lateral two third (Fig: 1).

The sternal end is much enlarged, and directed medially with a slight forward and downward tilt. It articulates with the clavicular notch

of manibrium sterni and the first costal cartilage to form the sternoclavicular joint. Its articular surface is convex vertically and slightly concave from before backward. It is covered with fibro cartilage and gives attachment at the periphery to the fibrous capsule, above and behind to the articular disc which divides the joint into two compartments. Close to the sternal end, the undersurface of the shaft presents a depression for the attachment of costoclavicular ligament by which it is connected to the first rib and its cartilage.

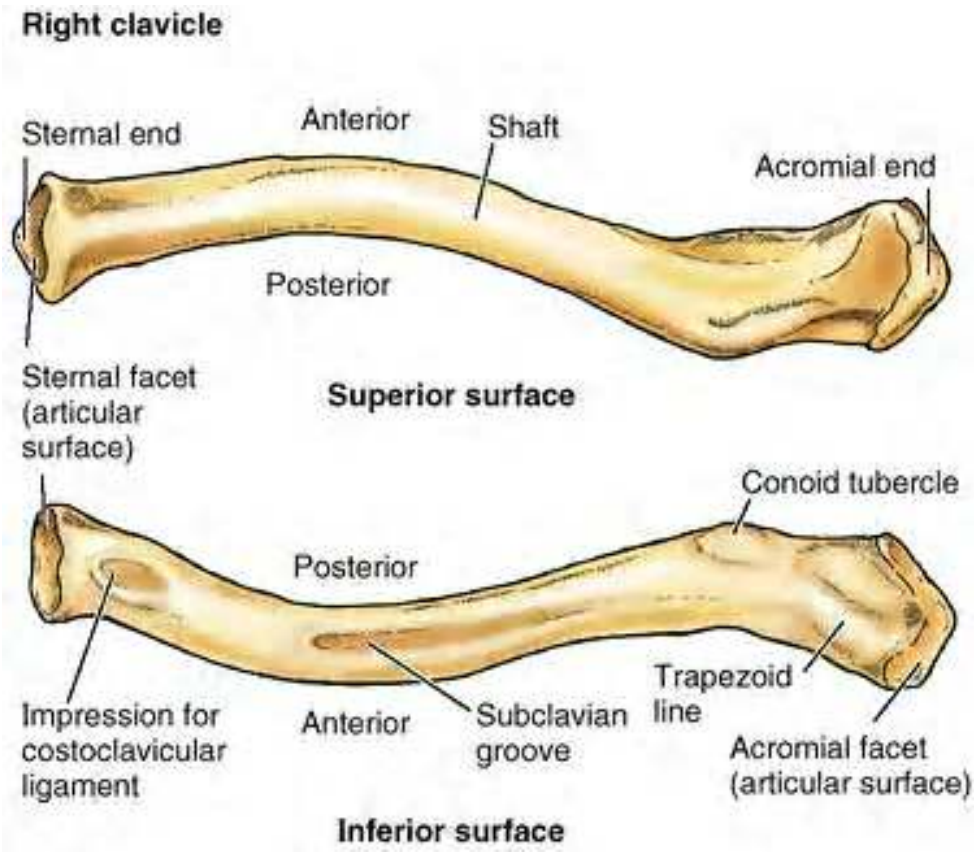


Fig:1

The acromial end is flat and bears an oval facet which is directed laterally and downward. It articulates with a similar facet on the anterior part of the medial border of the acromial process of scapula to form acromioclavicular joint. When the acromian is dislocated, it is driven under the clavicle.

The shaft of the clavicle is functionally divided into 2 parts

(a) Flattened lateral one third which suspends the scapula by attachment of strong coracoclavicular ligament;

(b) Cylindrical or prismatic medial two thirds which actually transmits the force from the upper limb and acts a long bone.

Lateral one third- it presents concave anterior border, subcutaneous upper surface, and lower surface which is provide with a conoid tubercle close to the posterior border at the junction between medial two thirds and lateral one third, and a trapezoid ridge extending forward and lateral from the conoid tubercle.

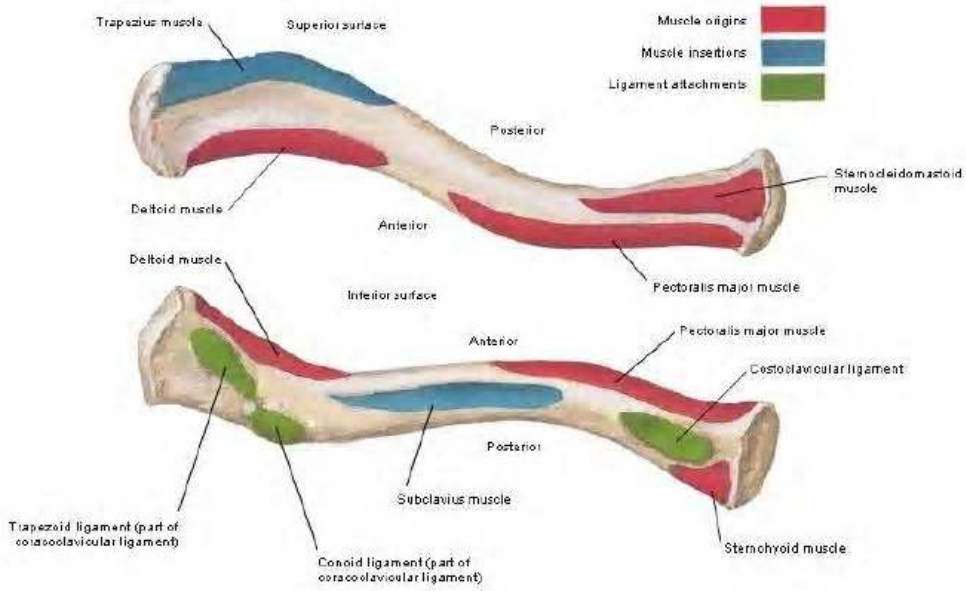


Fig: 2

Anterior border and the adjoining upper surface give origin to the anterior part of deltoid muscle; posterior border and the adjacent upper surface receive insertion of the anterior fibers of trapezius muscle (fig 2). The conoid tubercle and the trapezius ridge of the lower surface give attachment respectively to the conoid and trapezius part of coracoclavicular ligament.

Medial two thirds- it presents anterior, posterior, superior and inferior surf aces without any limiting border.

Inferior surface exhibits a longitudinal groove in the middle one third for the attachment of subclavius muscle and the two lips of the groove give attachment to clavipectoral fascia (fig 2). Close to the sternal end, the inferior surface presents a depressed area for the attachment of coracoclavicular ligament.

Anterior surface give origin to the pectoralis major in the medial half, between pectoralis major and deltoid, the clavicle forms the base of delto pectoral triangle (fig 2, 3).

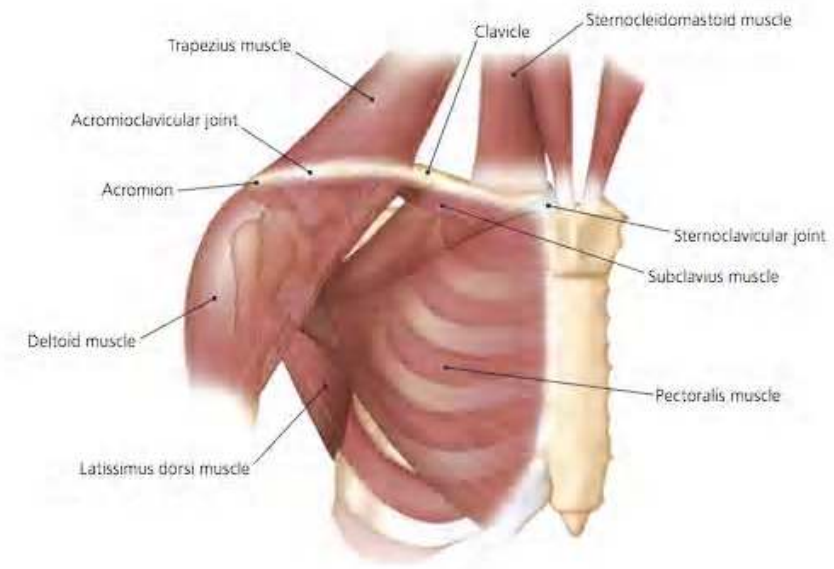


Fig: 3

Superior surface gives origin to the clavicular head of sternocleido mastoid in the medial one third; the gap between the trapezius and sterno-cleidomastoid forms the base of posterior triangle of the neck and gives

attachment to the two lamellae of the investing layer of deep cervical fascia enclosing a supra clavicular space.

In between the attachment of four muscles, the entire antero superior surface of the clavicle is palpable, and covered by the skin and platysma , and is crossed by three branches of supraclavicular nerve (C3,C4);occasionally the intermediate branch pierces the bone.

Posterior surface is smooth and concave; close to the sternal end, it gives origin to a part of sternohyoid muscle.

Rest of the posterior surface is related to the following:

(a) Internal jugular, subclavian, and beginning of brachiocephalic vein the medial part;

(b) Subclavian artery and trunks of brachial plexus in the lateral part;

(c) Apex of the lung covered by cervical pleura and suprapleural membrane;

(d) Supraclavicular vessels pass laterally along the upper part of the surface.

(e) Grants space :

It is formed by investing layer of cervical fascia anteriorly and omohyoid fascia posteriorly. Here external jugular vein join subclavian vein at its confluence with internal jugular vein

Joints related to clavicle:

a) Sterno clavicular joint:

It is a saddle type of synovial joint (Fig 4). Bones forming the joint are sternal end of clavicle and clavicular notch of manubrium sterni and upper surface of first costal cartilage. The sternal end of clavicle is covered by a fibro- cartilage. The articular surface of clavicle is convex from above downwards and slightly concave from before backwards. An articular disc made of fibro-cartilage, intervene between the clavicle and sternal notch. The articular disc prevents medial displacement of clavicle when a force is applied to the shoulder region.

Range of motion is approximately 30 to 35 degrees of upward elevation about 35 degrees in anteroposterior direction and rotation along long axis is about 40 degrees. Most sternoclavicular elevation occurs between 30 and 90 degrees of arm elevation. Fusion of sternoclavicular joint limits abduction to 90 degrees.

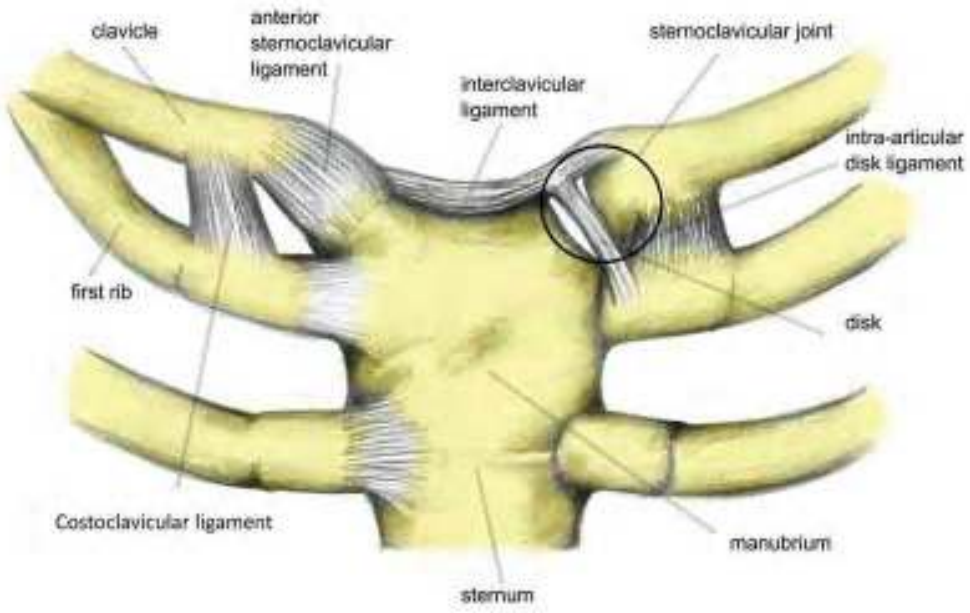


Fig: 4

b) Acromio clavicular joint

It is a synovial joint (Fig 5). Bones forming the joint are lateral end of the clavicle and clavicular facet on the medial margin of the acromian process of scapula. Both bones possess small, oval articular surfaces which are covered with fibro-cartilage. The clavicular facet faces laterally and downward to meet the acromion facet which is inclined in opposite direction. Therefore in dislocation of the joint the acromion process is driven below the lateral end of clavicle. The joint cavity is divided by an articular disc which project from the upper part of fibrous capsule. Rockwood et al reported 5 to 8 degrees of elevation or depression at

acromio clavicular joint with forward elevation and abduction to 180^0.On full overhead elevation the clavicle rotates about 40 degree along its axis.

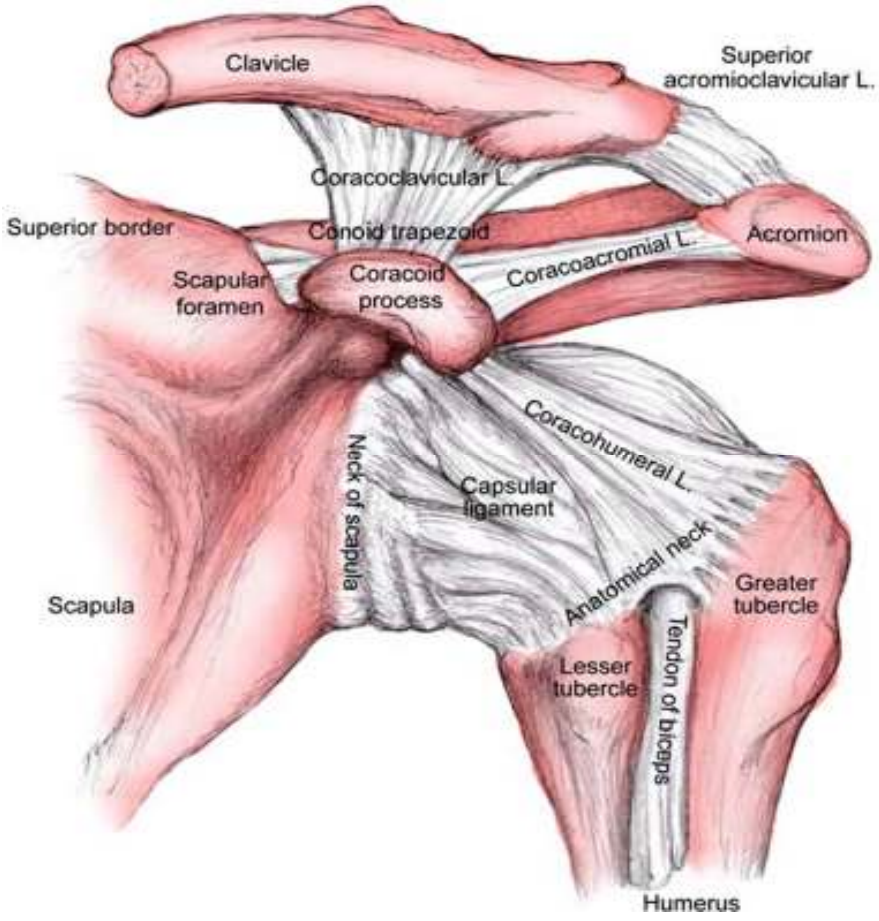


Fig: 5

Ligaments related to clavicle:

A) Medial ligaments (Fig 3):

a) Inter clavicular ligament:

The interclavicular ligament attached between medial end of clavicle and superior sternum and opposite clavicle. Shoulder elevation looses this ligament.

b) Costoclavicular ligament:

This is a ligament extending from first rib to sternum and clavicle. It has anterior and posterior fibers. It stabilizes the medial end of clavicle during movements.

c) Capsular ligaments:

These are specific thickening of the sterno clavicular joint capsule. This is the strongest especially antero superior and posterior fibers prevents upward displacement of medial end of clavicle and downward displacement of lateral end of clavicle.

B) Lateral ligaments

a) Acromio clavicular ligaments (Fig 4):

The acromio clavicular joint capsule thickens to form the acromio clavicular ligaments. It prevents the antero posterior movement of the distal end of clavicle.

b) Coraco clavicular ligaments :

It extends from base of the coracoid process to the inferior aspect of lateral end of clavicle. It has two parts. The trapezoid part and the conoid part. They are thick strong ligaments. It provides vertical stability and suspends the shoulder girdle from the clavicle.

ANATOMICAL POSITON

Place the enlarged sterna end medially, and somewhat forward and downward, rough markings of the shaft and groove for subclavius inferiorly, and the curvature of the anterior surface is convexo-concave from medial to lateral side.

Ossification-

The shaft is ossified from two primary centers, medial and lateral, in membrane between the 5^{th} and 6^{th} weeks of intrauterine life; the centers

subsequently fuse to form a single centre. It is the first bone to start ossification.

A secondary centre for the sterna end appears in cartilage at about 18 years; its fusion with the shaft starts at about 21 years and is completed as late as 31 years. Therefore, it is the last bone to complete ossification. The sternal end is the growing end and the nutrient vessels are directed laterally.

Sometimes a secondary centre appears for the acromial end.

FUNCTIONS OF CLAVICLE

1) Power and stability of the arm :

Clavicle provides stability as well as power to the shoulder girdle during the movement of arm above the shoulder level. It also keep the shoulder in a more lateral position thus help in dealing with the three dimensional environment.

2) Motion of the shoulder girdle:

It is the connecting link between shoulder and sternum.

3) Muscle attachments:

It provides origin of pectoralis major, sterno cleido mastoid and deltoid muscle and insertion of trapezius and subclavius.

4) Protection of neurovascular structures:

The neurovascular structures (Subclavian vessels, brachial plexus) and pleura lie just behind the medial $3/5^{th}$ of the posterior cortex of clavicle. The tubular structure along with the muscle attachments protects the underlying neurovascular structures.

5) Protection to lungs:

Along with rib cage clavicle protects the superior aspect of lungs.

REVIEW OF LITERATURE

Middle third clavicle fracture:

In the beginning clavicle fracture is given little importance and usually treated conservatively. But in the present fast moving world morbidity caused by calvicle fracture is a point of concern.

Many methods of treatment for clavicle fractures had been described even though a sling consistently gave good functional results. The management on clavicle fracture is first introduced by ancient Egyptians. Evidence on the non operative treatment of clavicle fractures dates back to the Edwin Smith Papyrus, written in the 17th century BC[2]. Hippocratus noted various observations about clavicle fracture at 400 BC.

In a randomised clinical trial by Kaisa Virtenan and Ville they compared operative with non operative management (Sling) of clavicular fractures. In their one year follow up study they found that non operative treatment with sling is associated with high non union rate[9].

In a study by Charles Neer only 3 of 2235 (0.1%) patients with middle third clavicle fracture treated by closed methods failed to heal and C Rowe study in 566 patients concluded that nonunion occurs only in

<1% of the patients[3,4]. But the drawback of these studies is both conducted in children, which usually unite always[5].

Fracture of middle third of the clavicle is greatly underrated with respect to pain and disability they produce especially during the first three weeks of treatment. It is also very difficult to support and immobilize a fracture of middle third of clavicle in an adult by external means with figure-of- eight bandages[5].

In a study by Hill in 66 mid third clavicle fractures treated conservatively, 31 % patients were unsatisfactory with the result, 25 % of patients complained of pain, 54% patients found the end result cosmetically displeasing[6].

Displaced middle third clavicle fracture treated non operatively usually associated with shortening[5]. Hill et al in his study concluded that shortening more than 2 cm is associated with poor outcome[6].

Chaithavat and V. Parkpian studied on 108 mid third clavicle fractures treated with Kirschner wires. They came to a conclusion that operative procedure is associated with low complication such as non union, mal union etc. The complication with this procedure is k-wire migration[11].

Jamal et al compared titanium nail over reconstruction plating and concluded that both plating and nailing give better function and low complications. He excluded all the markedly comminuted fractures in his study[23].

In a comparative study by Canadian orthopaedic society in 138 patients with mid third clavicle fracture plating gives better result in terms of time of union, functional outcome than patient treated non operatively[7].

In a multicentre, randomized, trial by C.M.Robinson et al comparing open reduction and plate fixation versus non operative treatment; he concluded that open reduction and rigid fixation is associated with less non union and better functional outcome[28].

In a study by Oliver et al in 39 athletes with mid third clavicle fracture treated with 3.5mm low contact locking compression plate showed average Constant score of 88 and union of fractures at 12 weeks post operatively. He concluded that plate fixation provides early union, pain relief and early return to sports activity[8].

In a Meta analysis of randomized control trials by R.C. McKee found out that operative management is associated with less non union and mal union[10]. The malunion rate was higher in non operative group.

Jerry et al studied on 100 clavicles to find out the clinical applicability of anatomic pre contoured plate. He found out that at the lateral aspect of clavicle bone there is a superior bow. Medial aspect of the superior surface of the clavicle is relatively flat, making it an ideal surface for plating[29].

In a retrospective case control study by Yu-Cheng Lai and Yih in 54 middle third clavicle fractures using locking compression plate and dynamic compression plate, they came to a conclusion that no significant difference is obtained in union or functional outcome[12].

In a biomechanical comparative study between LCP and reconstruction plate showed better biomechanical stability is obtained by using Locking compression plate[13].

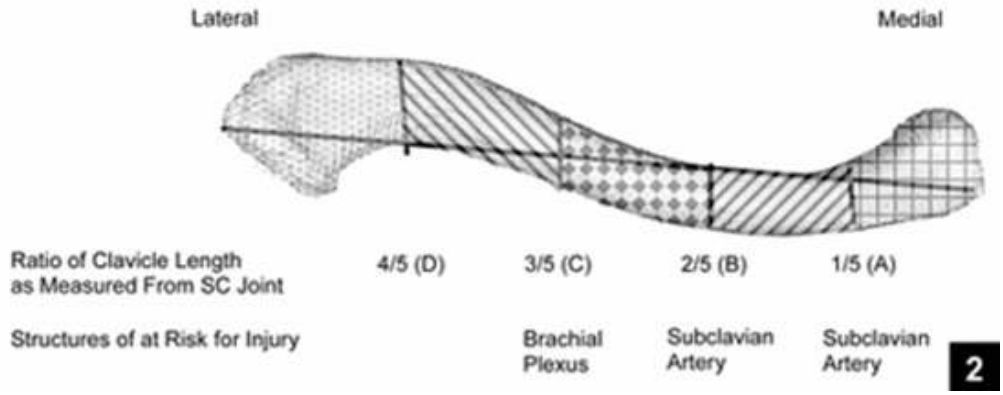
In a study by Chin-en-chen,in 26 patients, plating done on antero inferior aspect of clavicle and he came to conclusion that plating in antero inferior part is associated with few complications, less hard ware prominences and early return of shoulder function[14].

In a comparative study by Nathan Foramaini et al between antero inferior plating versus superior plating for clavicle fractures, he came to a conclusion that there are no significant differences between superior and antero inferior plating[15].

Dhoju et al studied on mid third clavicular fractures treated by superior reconstruction plate and concluded that superior plating provides biomechanical stability especially if there is comminution of inferior cortex[18].

Michael et al studied on mal unions of clavicle. He was done corrective osteotomy and internal fixation. Malunion is a complication of clavicle fracture treated non operatively. Corrective osteotomy and internal fixation gives a patient satisfaction and good functional outcome[30].

Eddie et al studied on the neurovascular risk associated with antero inferior plating. He studied the distance between posterior cortex of clavicle to the neurovascular structures (Fig 6). He also observed that superior clavicular plating has the advantages of plating over the tension side. The disadvantages are shorter screw length and prominent hard ware[16]. He also observed that neurovascular structure is close to the medial 3/5th of clavicle.



Distance of Each Vital Structure From Points Along the Clavicle

	Point A[a]	Point B[b]	Point C[c]
Subclavian artery, mm (SD)	22.95 (3.16)	15.10 (4.70)	N/A
Brachial plexus, mm (SD)	N/A	N/A	12.76 (4.09)
Pleural cavity, mm (SD)	33.83 (4.88)	25.61 (6.34)	26.69 (5.48)

[a]1/5 from sternoclavicular notch.
[b]2/5 from sternoclavicular notch.
[c]3/5 from sternoclavicular notch.

Fig 6

Elidrissi et al studied retrospectively on 34 cases treated by plateosteosynthesis using reconstruction plate. He concluded that plate fixation of completely displaced midshaft clavicular fracture provides stable fixation and improves the functional outcome[17].

MECHANISM OF INJURY

Fall on the shoulder is the most common cause for the fractures of the middle shaft fractures of the clavicle. It can occur in many ways such as fall from a vehicle or during a sports event (Fig: 7). As we know clavicle act as a strut between shoulder and the sternum. So any direct force which is more than the ability of the bone to withstand it causes failure in three ways. First is fracture of the clavicle, AC joint disruption or Sc joint disruption.

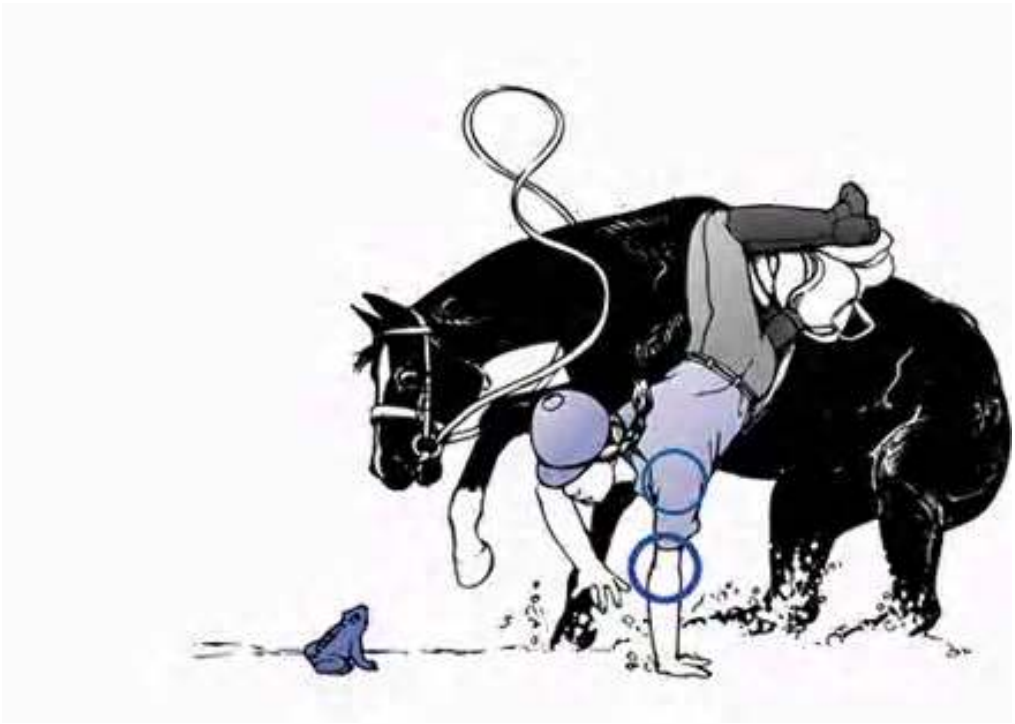


Fig : 7

Other cause is fall on outstretched hand. Most of the fractures of clavicle occur at mid third region because it is the narrowest portion and soft tissue coverings are little. If the mechanism of injury is trivial then you have to rule out pathological fractures.

Fracture Biomechanics

The clavicle is the origin and insertion for so many structures and the same structures causes displacement of fracture fragments.

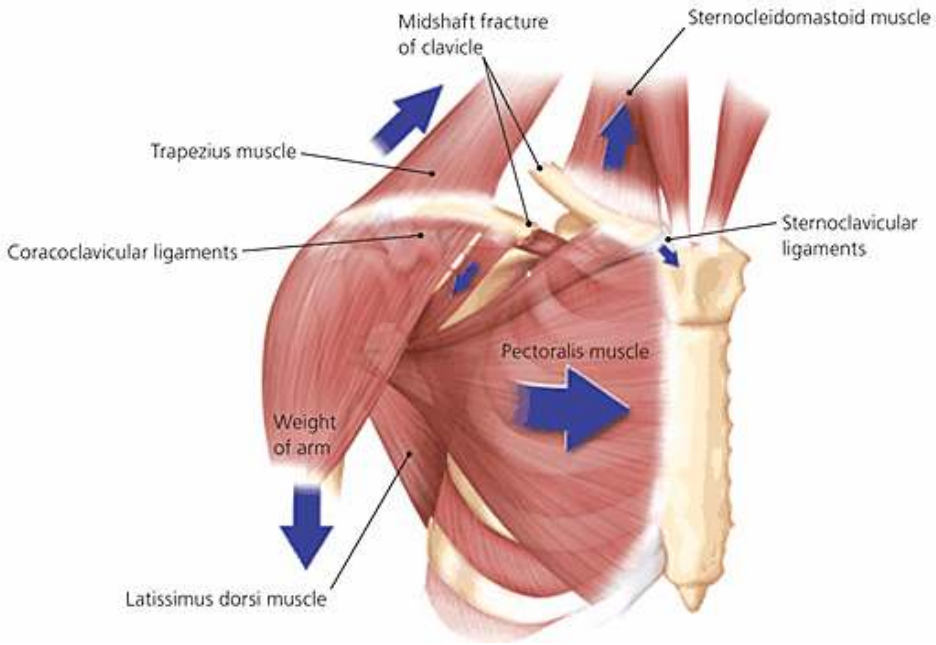


Fig: 8

Sternoclavicular ligaments stabilize the medial segment and sternocleido mastoid pulls it upward. Body weight acting through the coraco clavicular ligament pulls down the distal fragment.

Clinical findings:

Patient or relatives usually gives history of direct or indirect injury to the shoulder. The vast majority of fractures will result from a simple fall, a fall from a height, a fall during a sport activity or a motor vehicle accident.

Patient may tilt their head towards the affected side of injury to relax the trapezius muscle. By gravity and pull of pectoralis minor muscle the affected arm droops downwards and forwards. Because of this the postero superior angulation increases which is usually seen in displaced clavicular fractures.

Contusions may be seen over the fracture site. Marked displacement of fracture fragments may produce tenting of the skin. Examination shows tenderness at the fracture site. Gentle manipulation usually produces crepitus. Movements of the shoulder will be painful in all directions.

ASSOCIATED INJURIES:

Associated injuries can occur along with fracture of the clavicle.

It can be divided into –

1) Injury to the skeletal structure.

2) Lung and/or pleural injury

3) Injury to the vessels

4) Injury to the brachial plexus.

1) Skeletal injuries may include

a) Dislocation or fracture dislocation of sternoclavicular or acromioclavicular joints.

b) Injury to the cranio facial skeleton.

c) Fractures of the ribs.

d) Fracture of clavicle along with the scapula is known as floating shoulder.

The combination of ipsilateral fracture of the clavicle and scapular neck has traditionally been called the “floating shoulder”. It is considered as an unstable injury and may require operative fixation. This injury is considered as a subgroup of superior shoulder suspensory complex. It

includes both bone and soft tissue circle, or ring of the glenoid, corocoid process, coraco clavicular ligament, clavicle, acromio clavicular joint and the acromion. This is important biomechanically and maintains the anatomic relationship between upper extremity and axial skeleton. If operative intervention is chosen, then anatomic reduction and internal fixation of the clavicle is performed first and the shoulder is then reimaged. If the fixation result in indirect reduction of the glenoid no further intervention is required. If the glenoid remains in unacceptable position then fixation of glenoid neck is indicated[27].

2) Pleura and Lung : Apical pleura lies close to clavicle. So fracture of the clavicle may produce pneumothorax or haemothorax.

3) Vascular injuries are rarely occurs. It can cause laceration, occlusion or spasm of vessels. The most commonly injured vessels are subclavian artery or vein and internal jugular vein.

4) Injury to brachial plexus is often associated with subclavian vascular injury.

Radiographic evaluation:

A) Evaluation of middle third clavicle fractures:

The clavicle not only shortens but also become angulated inferiorly and rotated medially and the deformity is truly in two planes. To get a clear cut position of fragment position at least two projections of the clavicle are needed. These are an anteroposterior view and a 45 degrees cephalic tilt view.

B) Evaluation of acromioclavicular joint and distal clavicle:

Anteroposterior oblique stress film with the patient standing and 10 pound weights are suspended from each wrist should be sufficient to diagnose an unstable distal clavicle fracture.

C) Evaluation of sternoclavicular joint:

Antero posterior view may fail to identify these fractures because of the overlap of ribs, and shadows of mediastinum. A cephalic tilt (40 degree) view of both clavicle and a CT scan or bone scan may be helpful to diagnose this fracture.

CLASSIFICATION

ALLMAN

- Group I: Fractures of the middle third of clavicle.
- Group II: Fractures of the lateral third of clavicle.
- Group III: Fractures of the medial third of clavicle.

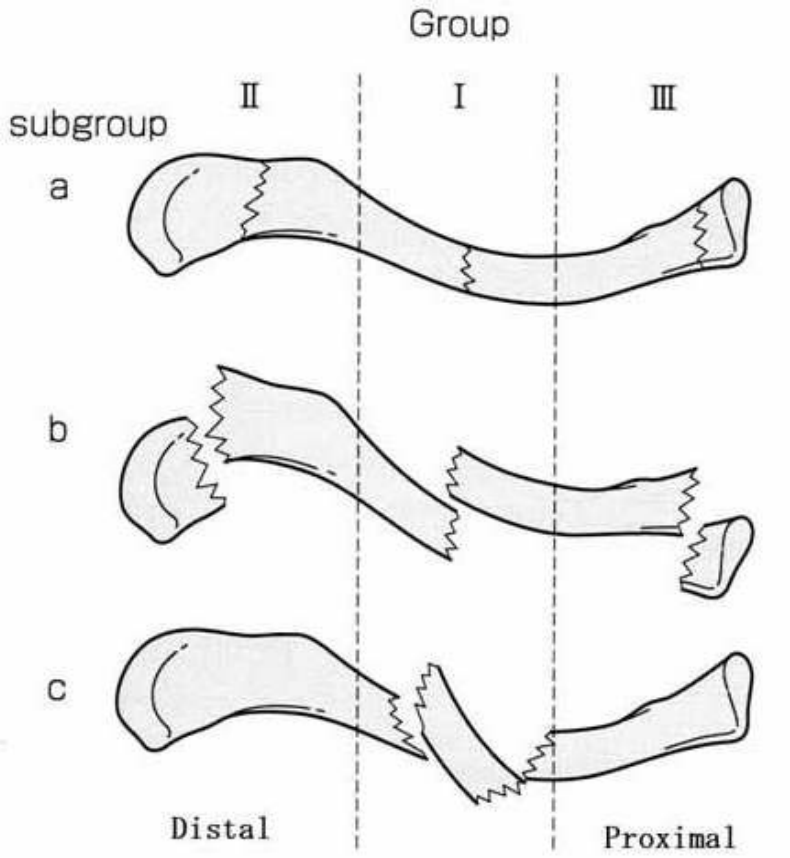


Fig:9

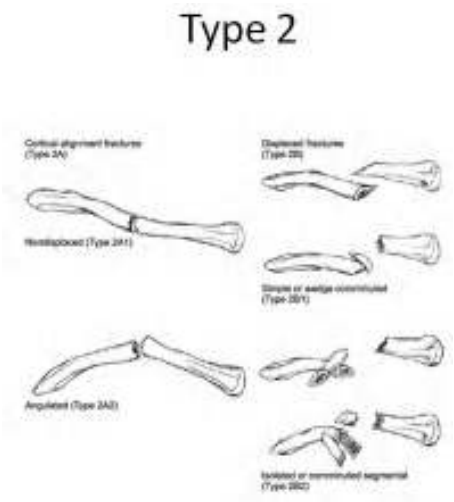
ROBINSON

Type 1 medial

- A Nondisplaced
- A1 Extraarticular
- A2 Intraarticular
- B Displaced
- B1 Extraarticular
- B2 Intraarticular

Type 2 middle

- A cortical alignment
- A1 nondisplaced
- A2 Angulated
- B Displaced
- B1 simple or single butterfly fragment
- B2 comminuted or segmental



Type 3 distal

- A Nondisplaced
- A1 Extraarticular
- A2 Intraarticular

B Displaced

B1 Extraarticular

B2 Intraarticular

TREATMENT MODALIIES

The treatment of clavicular fractures is still a debatable issue. Most of the old teaching is in favour of non operative management of clavicular fractures. But there are indications for primary fixation of clavicular fractures. These are

Fracture specific

1) Displacement >2cm
2) Shortening>2cm
3) Increasing communition>3 fragments
4) Segmental fractures.
5) Open fractures
6) Impending compound fracture with soft tissue compromise

Associated injuries

1) Vascular injury

2) Progressive neurological deficit

3) Ipsilateral upper extremity injuries

4) Floating shoulder

5) Bilateral clavicular fractures

Patient Factors

1) Poly trauma with requirement for early upper extremity weight bearing

2) Patient motivation for rapid return of function(sports persons)

Treatment modalities of middle third clavicular fractures include

Non operative:

Different types of immobilization include

a) Parham support[27].

b) Bohler brace.

c) Taylor support.

d) Velpeau wrap.

e) Modified Velpeau wrap.

f) Modified Sayre bandage.

g) Billington yoke (plaster figure-of-eight).

h) Commercial figure-of-eight.

Operative[27]:

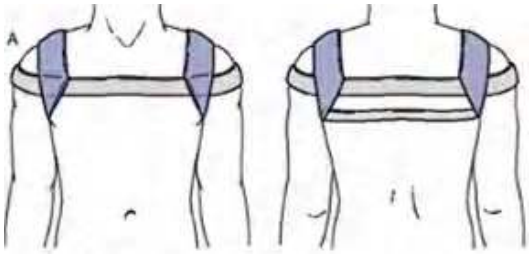
a) Closed reduction and nailing

b) Open reduction and plate osteosynthesis / nailing

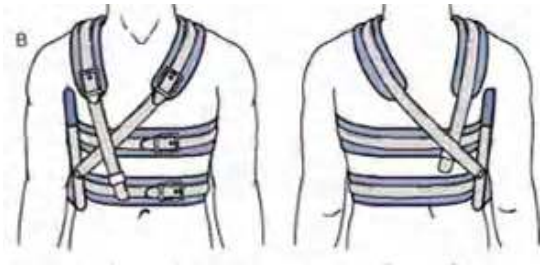
c) External fixation.

Conservative management:

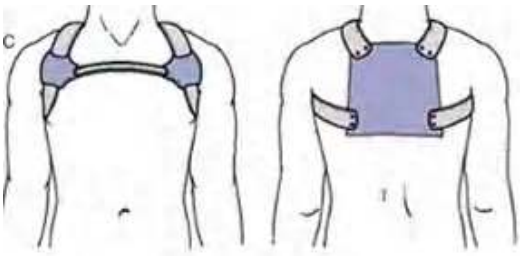
a) Parham support



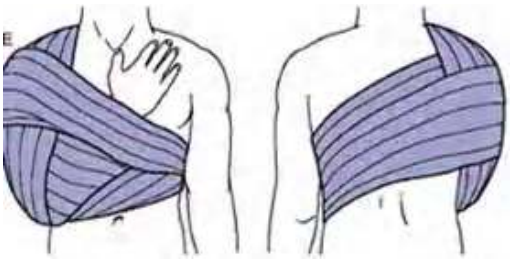
b) Bohler Brace



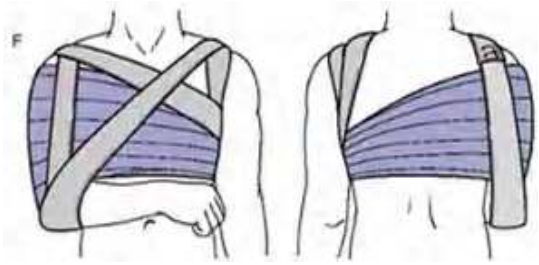
c) Taylor support



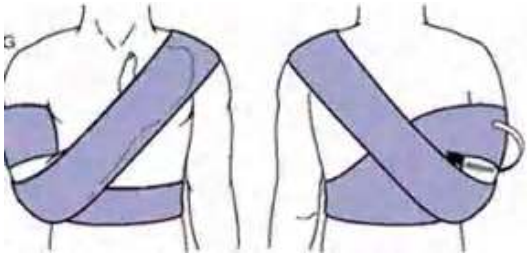
d) Velpeau Wrap



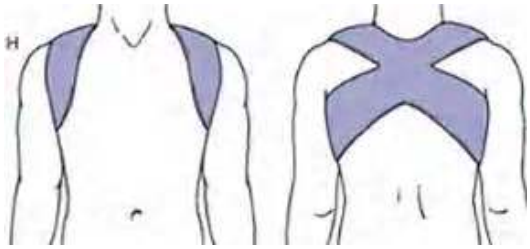
e) Modified Velpeau wrap



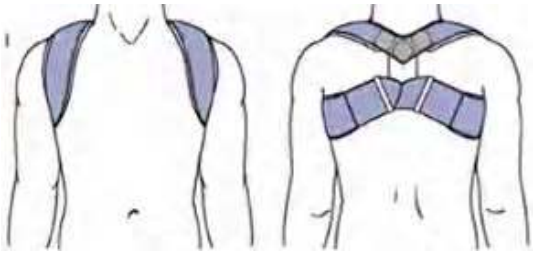
f) Modified Sayre bandage



g) Billington yoke (plaster figure-of-eight).



h) Commercial figure-of-eight



Operative technique:

A) Intramedullary nailing:

It is almost similar to intra medullary fixation of long bone fractures. Its advantages are smaller, cosmetic skin incision, decreased hardware prominence and lower incidence of fracture at the end of the implant. Its disadvantages are inability to lock the pin, Pin migration[45] failure to maintain axial length and rotation especially if there is fracture communition[32].

B) External fixation:

Open fracture of clavicle is an indication for external fixation. It takes the advantages of intrinsic healing ability of the clavicle and allows restoration of length.

C) PLATE OSTEOSYNTHESIS:

Plate osteosynthesis is the current method of treatment for mid third clavicle fractures. Reconstruction plate or locking compression plate is commonly used to fix clavicle fractures.

Advantages:

1. For transverse fractures, compression across the fracture site is achieved.
2. For oblique fractures or butterfly fragments, lag screw fixation is possible with the plate functioning in a neutralization mode.
3. Rotational control of the fracture in achieved.
4. Rigid fixation allows the patient to early mobilization of the upper limb and early return to the activities of daily living.

Disadvantages:

- It includes the necessity for increased exposure and soft tissue stripping.
- The plate itself sits subcutaneous and can be the source of irritation.
- For plate removal another procedure is required.

Despite these short comings plate fixation utilizing careful surgical techniques is an excellent method of treatment for mid clavicular fractures.

Reconstruction plate[31] (Fig: 9):

The 3.5 mm reconstruction plate is used for surgery involving pelvis, acetabulam, distal humerus, clavicle and scapula. These plates are used with 3.5 cortical screws. The reconstruction plates have lateral notches between the holes, which enables twisting and bending in two dimensions. Special bending irons and players are available. Bending angles greater than 15^0 at any site should be avoided. Stiffness of the plate is further diminished by bending.

The oval hole permits some self compression if the screw is inserted eccentrically. The screws also accept 4mm cancellous screws. It is made up of stainless steel and available in a variety of precontoured shapes, including:

a) Straight reconstruction plate.

b) Curved reconstruction plates.

c) J- shaped reconstruction plates

d) Pubic symphysis plate.

Dimensions[31]:

Thickness	2.8mm
Width	10mm
Hole spacing	12mm.

Fig: 9

Fig: 10

3.5 cortical screws (Fig 10)[31]:

3.5 mm cortical screws are made of 316L or titanium. It is fully threaded and non self tapping screw. Its dimensions are

a) Head diameter	6.0 mm
b) Thread diameter is	3.5 mm
c) Hexagonal socket	2.5 mm
d) Core diameter	2.4 mm
e) Pitch	1.25 mm
f) Drill bit	2.5 mm
g) Tap	3.5 mm

Locking compression plate (Fig: 11):

Locking compression plate is made of stainless steel or titanium. It provides angular stability. Pre contoured plates are available for superior and anterior plating. Combi hole helps the surgeon in using the plate in both conventional and locking technique. Limited contact plate decreases plate to bone contact. We can use 3.5mm cortical screws and locking screws.

Fig: 11 Fig: 12

3.5 mm locking screws (Fig 12):

a) Thread diameter 3.5mm

b) Core diameter 2.9mm

c) Pitch 0.8mm

d) Drill bit 2.8mm

3.5 mm locking screws are made up of 316 L or titanium. They are Self tapping. Head locks perpendicular to long axis

Anatomical clavicle plate:

Reconstruction plate needs pre contouring to maintain the reduction at fracture site. This can be avoided by using anatomical clavicle plate. By using anatomical plate there is a reduction in the net operative time.

Complications of clavicle fractures:

a) Malunion:

In adults there is no remodeling potential for the bone. So shortening or angulation occur as a common complication of displaced clavicular fractures. In a study it is found out that shortening less than 15mm is associated with pain.

b) Delayed union[20]:

The delayed union in clavicle is defined as the union that occurs between twelfth and twenty four weeks.

c) Nonunion:

Non union is defined as when union not occurred within 24 weeks. The causes of non union of clavicular fractures are

1) Inadequate immobilization

2) Markedly displaced (>2cm) fractures.

3) Muscle forces displacing the fracture fragments.

Various techniques have been described for the treatment of non union of clavicle. They are Intra medullary fixation, Plating with bone grafting or partial cleidectomy[46].

d) Neurovascular sequelae:

Neurovascular sequelae can occur in both united and un united fractures. Abundant callus or the fracture deformity may narrow the costoclavicular space[4]. It can cause compression of neurovascular structures and produce symptoms.

Complications of surgery and its treatment:

1) Hard ware problems:

As with fresh fracture fixation inadequate purchase or plate size, collapse of the intercalary graft are important predictors of failures like

plate loosening, plate angulation, plate breakage which may be treated by re plating.

2) Infection:

Infection is a nightmare for orthopaedic surgeons. Superficial infection can be treated with antibiotics. Deep infection need wound debridement and higher antibiotics.

3) Hypertrophic scar:

Another complication is hypertrophic scar. It can be treated by scar excision at the time of plate removal.

4) Non union, delayed union and malunion :

These complications are very rare after plate osteosynthesis. It can be treated by re plating and bone grafting.

MATERIALS AND METHODS

This prospective study is an analysis of functional outcome of 34 cases of displaced middle third clavicular fractures, internally fixed by plateosteosynthesis which was undertaken at the department of orthopaedics and traumatology at Government Mohan Kumaramangalam Medical College and Hospital, Salem from November 2011 to September 2013. During this period 34 cases of clavicle fracture treated surgically.

Inclusion criteria:

a) Age > 18 years and < 60 years.

b) Fracture specific

1) Displacement >2cm

2) Shortening>2cm

3) Increasing communition>3 fragments

4) Segmental fractures.

5) Open fractures

6) Impending compound fracture with soft tissue compromise

Associated injuries

1) Vascular injury

2) Progressive neurological deficit

3) Ipsilateral upper extremity injuries

4) Floating shoulder

5) Bilateral clavicular fractures

Patient Factors

1) Poly trauma with requirement for early upper extremity weight bearing

2) Patient motivation for rapid return of function (sports persons)

Exclusion criteria:

a) Age <18 years and >60 years

b) Un displaced or minimally displaced fractures**.**

c) Any medical contraindication to surgery (Heart diseases, renal failure or active chemotherapy).

Preoperative preparation of patients:

- Patients were kept fasting for 6 hours before surgery.
- A written informed consent for surgery was taken.
- The neck, chest, axilla, shoulders and arm were prepared.
- Transquilizers were given as advised by the anesthetist.
- A systemic antibiotics usually inj. taxim 1gm intravenously were administered 30 minutes before surgery to all patients.
- All patients were operated under general anaesthesia.

MIDDLE THIRD CLAVICLE FIXATION:

Instruments used for plate fixation:

- 3.5mm reconstruction plate, 1/3 tubular plate.
- 2.7 mm drill bit
- 3.5mm universal drill guide.
- Hand drill/pneumatic drill
- 3.5mm Tap for cortical screw
- Depth gauge
- 3.5mm cortical screw of varying sizes (12-22mm).

- Hexagonal screw driver.
- General instruments like retractor, periosteal elevator, 3.5 system reduction clamps and bone lever.

Locking compression plate

- 2.8 mm drill bit
- 2.8mm threaded drill guide.
- Hand drill/pneumatic drill
- Depth gauge
- 3.5 mm locking screws.
- Hexagonal screw driver.
- General instruments like retractor, periosteal elevator, 3.5 system reduction clamps and bone lever.

Operative Procedure:

Place the patient in supine position with sand bag between the scapulae. Keeping the sand bag allows the shoulder girdle to falls backward. It restores the length and increases the exposure to clavicle. Make an incision along the axis of the clavicle, centering the fracture site. Subcutaneous tissue along with platysma incised together and mobilized.

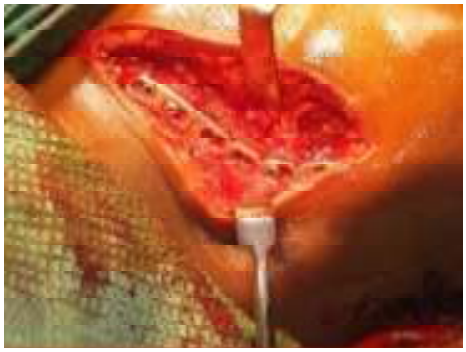
Myofascial layer is incised and elevated. Fracture site exposed. Periosteum elevated. Fracture ends freshened. Fracture reduced using bone clamps. If there is a comminuted wedge fragment fix it with a lag screw. Precontoured reconstruction plate or anatomical clavicular plate is used. The Plate is placed over the superior surface of the clavicle.2.7mm drill bit is used. Screw size measured with depth gauge. Tapping was done with 3.5mm tap. 3.5 mm cortical screws are used for reconstruction and locking screws in locking plate. Minimum of six cortical purchases was attained on either side of the fracture. Myofascial layer followed by skin and sub cuticular tissue sutured. Sterile dressing applied and immobilized in a shoulder immobilizer.

1. Supine position with sang bag under the shoulder

2. Skin incision

3. Reduction

4. Fixation with anatomical plate



5. Applying locking screws

6.Subcuticular suturing.

Post operative protocol:

- Patients were kept nil orally for 4 to 6 hours post- operatively.

- Intravenous fluids were given as needed.
- Antibiotics were continued for 5 days.
- Analgesics and tranquilizers were given according to the needs of the patient.
- The operated upper limb was immobilized in an arm pouch.
- Check x-rays were taken to study the alignment of fracture fragments.
- The wound was inspected at 2nd postoperative day.
- Suture removal was done on 12th postoperative day.
- Patients were discharged with the arm pouch.

Rehabilitation:

The objectives of rehabilitation are to improve and restore the function of the shoulder for activities of daily living, vocational and sports activities. Rehabilitation of the affected extremity were done according to the stage of fracture union and time duration from day of surgery.

Pendulum movements/ codman's exercises started from 3rd post operative day.

- 2 week: The sling discontinued and unrestricted range of motion exercise allowed.
- They followed every two weeks till 3 months followed by every 4 weeks till 6 months and every 8 weeks till one year.
- Sports activities and heavy weighting are avoided till 12 weeks.

The functional outcome was assessed by **Constant** and **Murley** score.

CONSTANT AND MURLEY SCORING:

The patients are graded as follows

CATEGORY:

A) SUBJECTIVE:

1) Pain - 15 Points

No pain - 15

Bearable pain - 10

Disabling pain - 5

2) Activities of daily living: - 20 Points

Ability to perform full work - 04

Ability to perform Leisure activities/Sports - 04

Unaffected sleep - 02

Level at which work can be done:

Up to Waist - 02

Up to Xyphoid - 04

Up to Neck - 06

Up to Head - 08

Above head - 10

B) OBJECTIVE:

RANGE OF MOVEMENTS: 40 POINTS:

a) Active flexion without pain

00 – 30 Degrees: 00

31-60 Degrees: 2

61-90 Degrees: 4

91-120 Degrees: 6

121-150 Degrees: 8

> 151 Degrees: 10

b) Functional external rotation:

Hand behind head with elbow forwards - 2

Hand behind head with elbow backwards - 4

Hand above head with elbow forwards - 6

Hand above head with elbow backwards - 8

Full elevation from on top of head - 10

c) Active abduction without pain:

With dorsum of hand on back, head of third metacarpal reaches

00 – 30 Degrees: 00

31-60 Degrees: 2

61-90 Degrees: 4

91-120 Degrees: 6

121-150 Degrees: 8

> 151 Degrees: 10

d) Functional internal rotation:

Ipsilateral buttock: 2

S1 spinous process: 4

L3 spinous process: 6

T12 spinous process: 8

T7 spinous process: 10

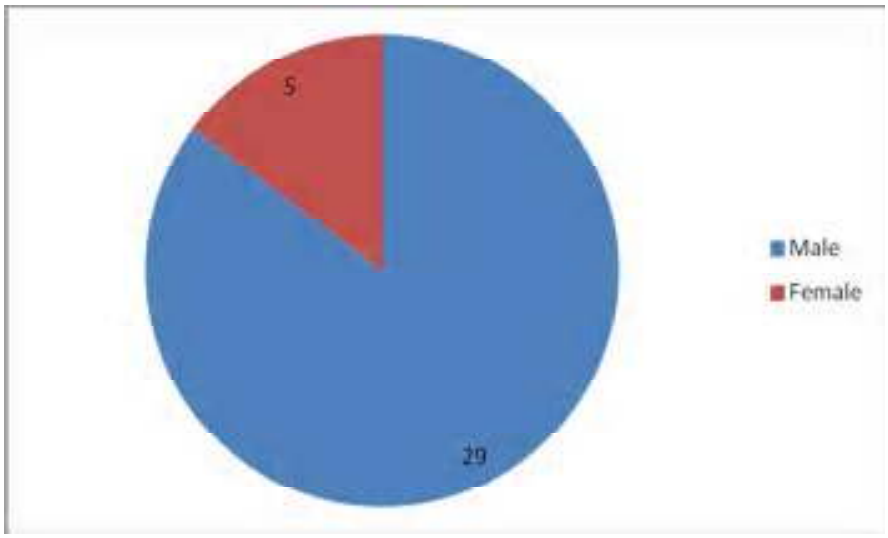
e) Strength of abduction: 25 Points

RESULTS

In our study 34 cases of displaced middle third clavicular fractures were treated with plate osteosynthesis using locking compression plate and reconstruction plate.

Out of the 34 cases 29 patients are male and 5 patients are female. Age of the patient varies from 20 years to 50 years. Duration of the study was from October 2011 to September 2013 with a mean follow up period for 1 year.

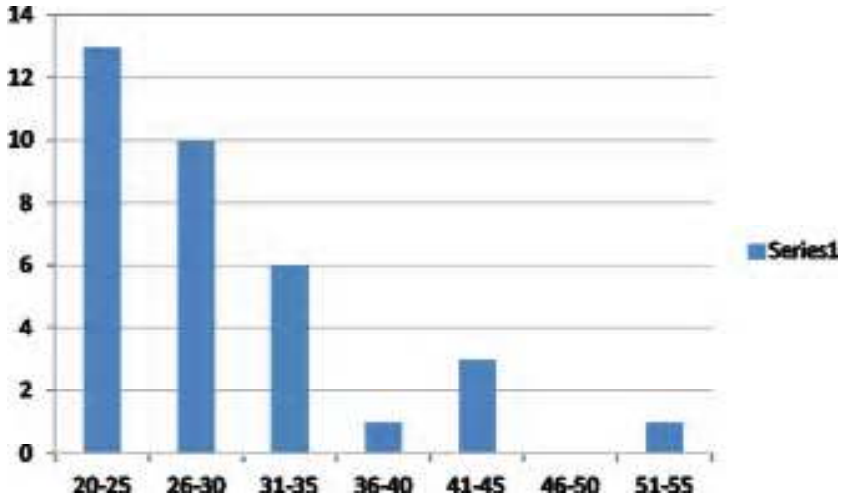
SEX RATIO	
Male	**29**
Female	**05**



SIDE	
Right	**24**
Left	**10**

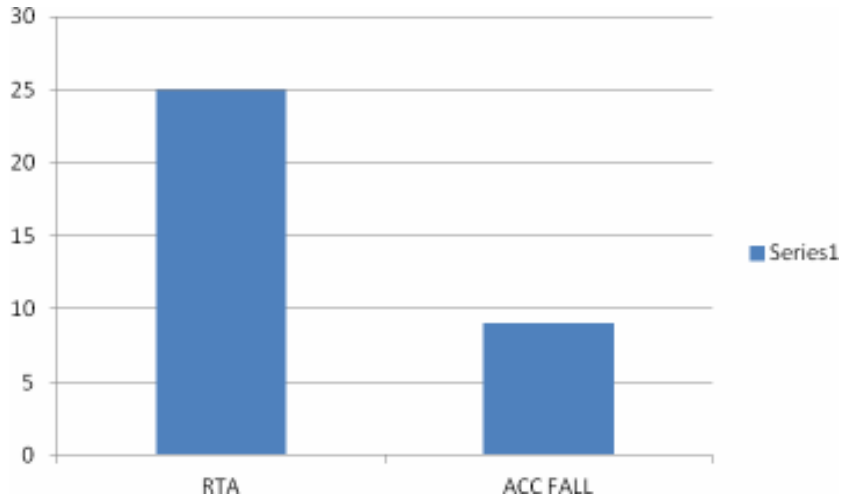
Out of the 34 patients 24 patients sustained injury to the right side and remaining 8 patients on left side.

AGE	
20-25	**13**
26-30	**10**
31-35	**6**
36-40	**1**
41-45	**3**
46-50	**0**
51-55	**1**
56-60	**0**



Out of the 34 cases 13 patients age was between 20 to 25 and 10 patients age was between 26 to 30.

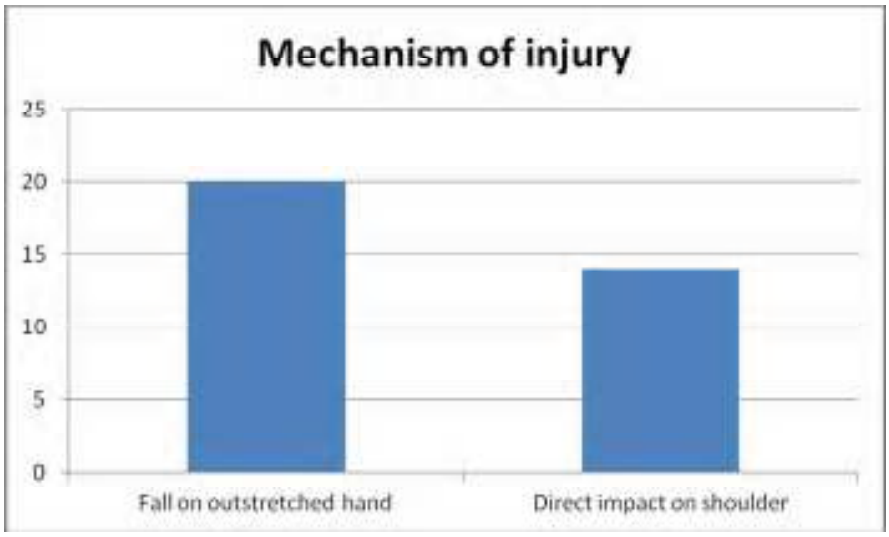
MODE OF INJURY	
RTA	**25**
ACCIDENTAL FALL	**09**



In majority of the cases RTA (25) was the cause for injury followed by accidental fall.

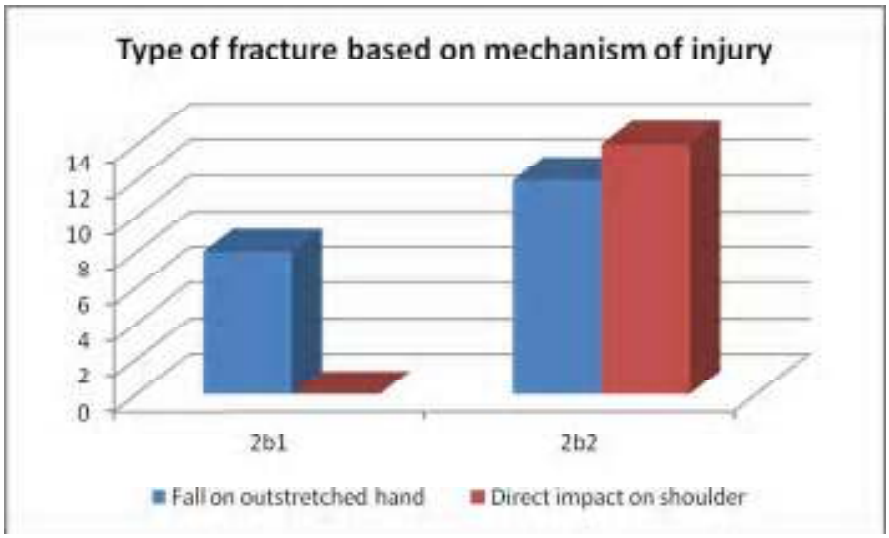
Mechanism of injury

Mechanism of injury	
Fall on outstretched hand	**20**
Direct impact on shoulder	**14**



In majority of the cases fall on outstretched hand (FOOSH) was the common cause of injury followed by direct impact.

Type of fracture based on mechanism of injury		
	2b1	**2b2**
Fall on outstretched hand	**8**	**12**
Direct impact on shoulder	**0**	**14**

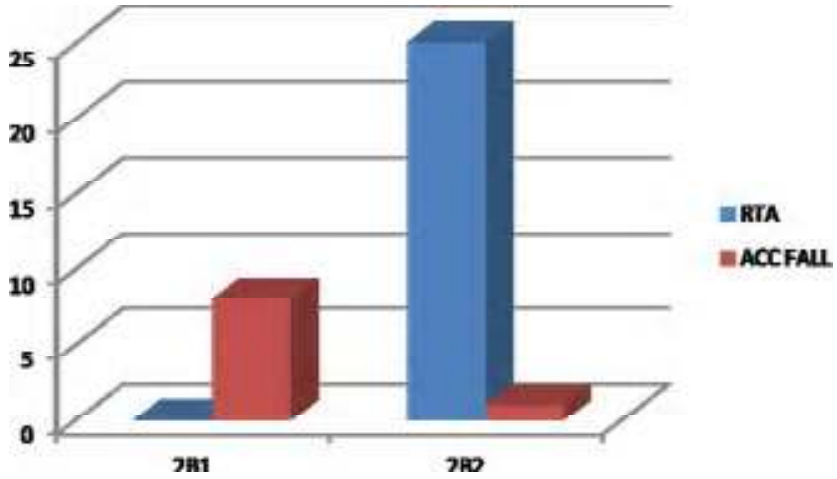


Direct injury to shoulder causes severely comminuted fractures.

Type of Fracture based on Mode of injury

(Based on Radiological and Intra operative findings)

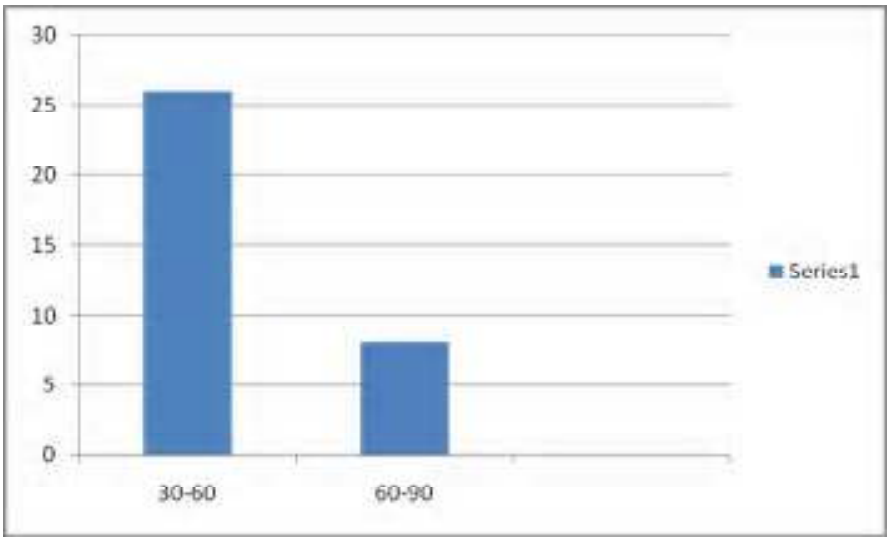
Type of Fracture based on Mechanism of injury		
	Type 2B1	**Type 2B2**
RTA	**0**	**25**
Accidental fall	**8**	**1**



In all cases of Road Traffic Accident there was communition at the fracture site.

TIME OF SURGERY	
30-60 minutes	**26**
60-90 minutes	**08**

In majority of cases (75%) operative time was less than one hour.



AVERAGE BLOOD LOSS: Average blood loss during the surgery was less than 100ml.

Time of Union	
<8 Weeks	**02**
8 weeks	**14**
10	**14**
12	**03**
>12 weeks	**01**

Out of 34 cases 16 cases united in 8 weeks and by 12 weeks all cases united except one. In one case there was implant failure and fracture mal union occurred.

Functional outcome:

Day today activities	
2-3 weeks	**24**
3-4 weeks	**09**
>4 weeks	**01**

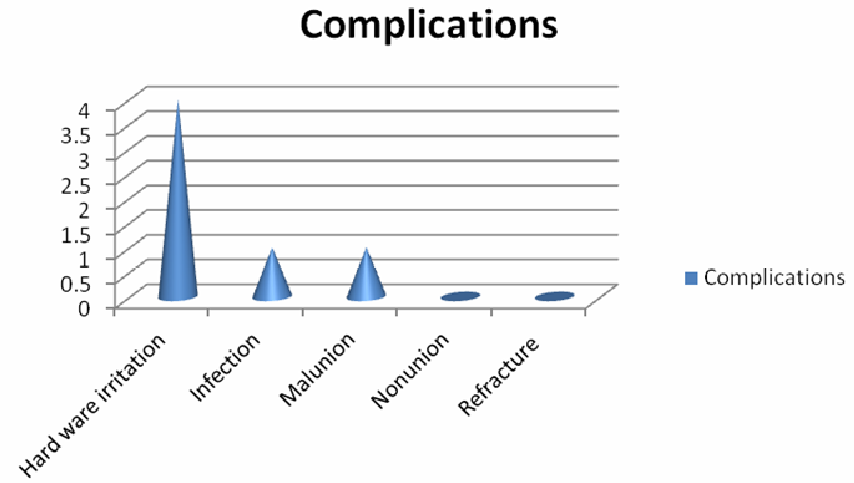
Out of the 34 patients 24 patients returned to day today activities after 2-3 weeks.

Return to work	
8-10 weeks	**03**
11-12 weeks	**18**
13-14 weeks	**09**
15-16 weeks	**03**
>16 week	**01**

Out of the 34 cases 30 patients returned to work within 3 months.

Complications:

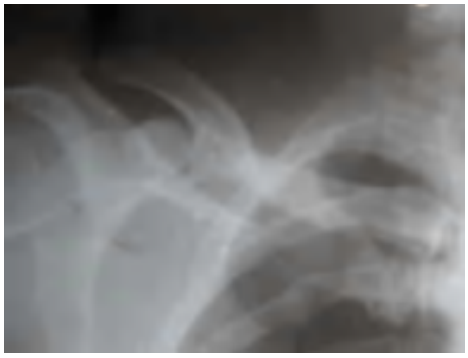
Hard ware Irritation	4
Infection	1
Delayed union	0
Nonunion	0
Mal union	1
Hard ware failure	1
Re fracture	0



CASE ILLUSTRATION

Case: 1

Name :	Rajendran
Age/Sex :	32/male
Mode of Injury :	RTA
Extremity :	Right
Open/closed fracture :	Closed
Associated Injury :	Nil
Reconstruction plate/ Locking plate :	Reconstruction plate
Robinson Classification:	2b2
Time of union:	10 weeks
Range of Movements:	Full
Complications:	Nil
Constant score:	Excellent



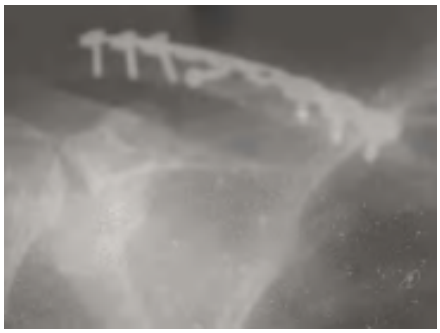
Pre operative

Intra operatve

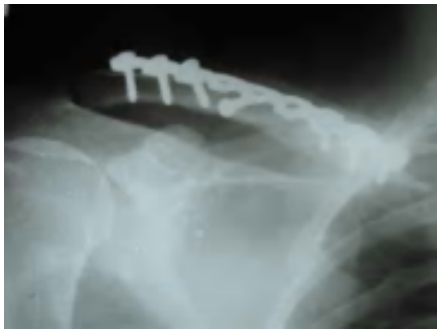
Intra operative

Immediate post operative

4 week



6 week



10 week

Functional Outcome

Case: II

Name :	Nagendran
Age/Sex :	26/male
Mode of Injury :	RTA
Extremity :	right
Open/closed fracture :	closed
Associated Injury :	nil
Reconstruction plate/ Locking plate :	Locking plate
Robinson Classification:	2b2
Time of union:	8 weeks
Range of Movements:	Full
Complications:	Nil
Constant score:	Excellent

Pre op

Immediate post op

4 week

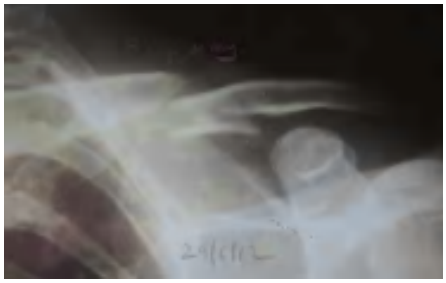
6 week

8 week

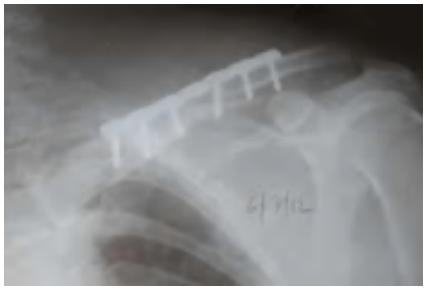
Functional outcome

Case: III

Name :	Periyasamy
Age/Sex :	42/male
Mode of Injury :	Accidental fall
Extremity :	Left
Open/closed fracture :	Closed
Associated Injury :	Nil
Reconstruction plate/ Locking plate :	Reconstruction plate
Robinson Classification:	2b2
Time of union:	8 weeks
Range of Movements:	Full
Complications:	Nil
Constant score:	Excellent



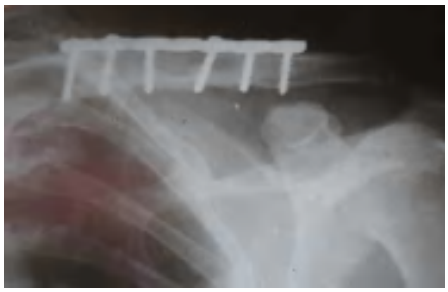
Pre op



Immediate post op

4 week

8 week



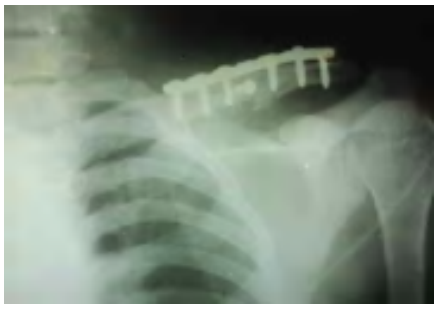
10 week

Functional outcome

Case: IV

Name :	Suresh
Age/Sex :	20/male
Mode of Injury :	Accidental fall
Extremity :	Left
Open/closed fracture :	Closed
Associated Injury :	Nil
Reconstruction plate/ Locking plate :	Reconstruction plate
Robinson Classification:	2b1
Time of union:	4 weeks
Range of Movements:	Full
Complications:	Nil
Constant score:	Excellent

Pre op



post op

4 week

Functional Outcome

Complications:

Case: V

Name :	Saravanan
Age/Sex :	23/male
Mode of Injury :	RTA
Extremity :	Left
Open/closed fracture :	Closed
Associated Injury :	Nil
Reconstruction plate/ Locking plate :	Locking plate
Robinson Classification:	2b2
Time of union:	8 weeks
Range of Movements:	Full
Complications:	Superficial infection
Constant score:	Excellent

Pre op

Post op

8 week

Superficial infection

Other complications:

Mal union.

Hard ware irritation

DISCUSSION

Clavicle fractures are usually treated conservatively. In a study conducted to analyze the results of conservative treatment by Hill et al in 1997, Nordqvist et al in 1998 and Robinson et al in 2004 found poor results following conservative treatment of displaced middle third clavicle fracture. So there is specific indication like displacement, with or without comminuted middle third clavicle fracture (Robinson Type-2B1,2B2).

The patients treated with early, rigid fixation of their clavicle fractures shared a high postoperative constant score, early pain resolution early return to activity and high patient satisfaction rating. Plating has the advantages of maintaining the length especially in comminuted fractures. There is little chance for hard ware breakdown and migration.

Clavicle nailing is an option for mid third clavicle fractures. Intra medullary nailing is difficult in clavicle because of the anatomical shape. Nailing has the advantages of less soft tissue dissection and periosteal disruption. The disadvantages are the following.

a) No static locking is available.

b) Hard ware can break.

c) Hard ware migration

d) Migration causes breakdown of skin or infraclaviclar structure injury.

e) In comminuted fracture shortening occurs over time[21].

In our study the clavicle fracture are more common in male than females. There were 29 male and 5 female patients. This is comparable with other studies by Elidrissi Mohammed et al where out of 34 patients 32 were male and two were females[17]. In a study by Dhoju et al out of 20 patients 16 were males and 4 were females. From this we can conclude that it is more common in active individuals[18, 20].

In our study right side clavicle is commonly involved than left side. This is also comparable with the study by Elidrissi Mohammed et al where out of 34 cases 28 were on right side and 6 were left side. From this we can come to conclusion that dominant hand involves usually[17].

In our study the average age group was 27.5 years. It is also comparable with study by Elidrissi et al[17]. This again indicates clavicle fracute is more common in active, working age group[20].

In our study Road Traffic Accident was the most common cause for clavicle fractures. Fall on out stretched hand was the commonest mechanism of injury. We studied the fracture pattern (intra operatve

finding) based on mode of injury and mechanism of injury. From this Robinson type 2b2 (comminuted mid shaft fracture) is associated with high velocity injury and direct impact on the shoulder.

In our study the average time taken for surgery was less than one hour. Average blood loss was less than 100ml.

The average time of union was 9.5weeks. It is also comparable with other studies like Elidrissi et al, Dhoju et al. Most of our patients return to work at 2 and a half month time.

Time of union	
Elidrissi et al	14 weeks
Dhoju et al	16 weeks
Olivier et al	12 weeks
Our study	9.5 weeks

We assessed the functional outcome using constant score. We got excellent result in all patients except one in which we used 1/3rd tubular plate. The patient came after 6 months for evaluation of pain, fracture found to be mal united after implant breakage. The patient was not willing for implant removal. He treated with analgesics. The mean

constant score in our study is 95.14. It is also comparable with other studies by Eldrissi et al and oliver etal.

Study	Constant score
Eldrissi et al	95.33
Oliver et al	88
Dhoju et al	97.45
C.M.Robinson et al	92
Our study	95.14

Study	Implant failure	Malunion/ Nonunion
Dhoju et al (Reconstruction plate)	Nil	Nil
Elidrissi et al (Reconstruction plate)	Nil	Nil
Olivier et al (low contact dynamic compression plate)	Nil	5%
Nathan et al (superior Reconstruction plate)	3%	20%
Our study (21 Reconstruction plate, 12 Locking plate, one 1/3 tubular plate)	3% (1/3 tubular plate)	3% (Malunion)

In our study there are 4 patients complained of hard ware irritation. In these patients functional outcome was good. We removed implant in 2 patients. There is no re fracture. We used high profile reconstruction plate. This complication can be avoided by using low profile plate.

One case had superficial infection. This was managed with intravenous antibiotics.

Infection		
Nathan et al	Superior plating	Nil
	Antero inferior plating	2.5%
Elidrissi et al		3% (deep infection)
Dhoju et al		5% (deep infection)
Our study		3% (Superficial infection)

In other studies deep infection is treated with early surgical debridement.

Superior plating has the advantage of plating over the tension surface. Superior plating is the preferred technique when there is inferior cortical communition. We considered stability more than cosmesis so our choice was superior plating than antero inferior plating which has less hard ware irritation[19].

According to literatures superior plating is associated with neurovascular complications. In order to avoid neurovascular injury we measured the clavicle size pre operatively and we adjusted the drill bit length.

In our study we used both reconstruction plate and locking compression plate. There is no significant difference in terms of union or functional outcome. But patient in which locking compression plate is used showed an early return to day today activities and work compared to the reconstruction plate group. Locking compression plate provides better biomechanical stability than reconstruction plate[22].

CONCLUSION

In our study Open reduction and rigid internal fixation of displaced midshaft clavicular fracture has resulted in good fracture union rate and excellent functional outcome.

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PROFORMA

Case No :

Name :

I.P.No. :

Age :

D.O.A. :

Sex :

D.O.D. :

Address :

Occupation :

DIAGNOSIS :

I) HISTORY :

Complaints :

Pain

Swelling

Duration

Side

Mode of injury:

Direct injury to the shoulder

Fall on outstretched hand

II) PAST HISTORY ;

III) GENERAL PHYSICAL EXAMINATION :

Pallor

B.P.

P.R.

Temp.

IV) LOCAL EXAMINATION :

i) Inspection :

Attitude

Swelling

Deformity

Skin

ii) Palpation :

Local rise of temperature

Tenderness

Bony irregularity

Crepitus

iii) Movements :

iv) Neurovascular status :

v) Associated injuries

vi) Complications (if any)

V) MANAGEMENT :

A) Investigations :

1) Blood : Hb% 2) Urine : Albumin

TC

DC

Sugar

ESR

3) Blood urea : 4) HIV

Blood sugar : HBsAg

S.creatinine : 5) ECG

6) X-ray clavicle with shoulder AP view

VI) Treatment :

i) Surgical procedure

ii) Indication

iii) Date of surgery

iv) Type of Anaesthesia

v) Implant used

vi) Immobilization after surgery- Duration

viii) Check x- ray :

ix) Rehabilitation :

VII) COMPLICATIONS :

VIII) FOLLOW UP :

Follow up			
	1st month	2nd month	3rd month
Pain			
Deformity			
Movements			
X ray findings			

IX) ASSESSMENT OF RESULTS :

By Constant and Murley scoring system grading is done as follows

Total score Result

90-100 : Excellent

80-89 : Good

70-79 : Fair

0-70 : Poor

PATIENT CONSENT FORM

Study Title: Functional Outcome of Displaced Middle Third Clavicular Fractures Treated by Plate Osteosynthesis.

Study Centre: Department Of Orthopaedics, GMKMCH Salem

Participant Name: Age: Sex: I.P. No:

I confirm that I have understood the purpose of surgical procedure for the above study. I have the opportunity to ask the question and all my questions and doubts have been answered to my satisfaction.

I have been explained about the possible complications that may occur during surgical and post-surgical procedure. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving any reason.

I understand that investigator, regulatory authorities and the ethics committee will not need my permission to look at my health records both in respect to the current study and any further research that may be conducted in relation to it, even if I withdraw from the study. I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from the study.

I hereby consent to participate in this study for various surgical procedures and their outcomes.

Time:

Date: Signature / thumb impression of patient

Place: Patient's Name:

Sl. No	NAME	AGE	IP NO	Date of Admission	Date of Surgery	GENDER	MODE OF INJURY	FOOSH/Direct injury	SIDE AFFECTED	ROBINSON CLASSIFICATION	ASSOCIATED INJURY	IMPLANT	DURATION OF STAY IN HOSPITAL	RETURN TO WORK	TIME OF UNION	INFECTION	PLATE LOOSENING	PLATE BREAKAGE	HARD WARE IRRITATION	DELAYED UNION	MALUNION	RESTRICTION OF SHOULDERFUNCTION	CONSTANT SCORE	RESULT
1	RAJENDRAN	32	38288	5.11.2011	14.11.2011	Male	RTA	D	Right	2b2	Nil	Recon plate	5	12	10	-	-	-	-	-	-	-	98	EXCELLENT
2	NATARAJ	26	75686	13.12.11	24.12.11	Male	RTA	F	Right	2b2	Nil	Recon plate	5	14	8	-	-	-	P	-	-	-	94	EXCELLENT
3	ARUL	23	996	6.1.12	10.1.12	Male	RTA	D	Right	2b2	Nil	Recon plate	4	14	8	-	-	-	-	-	-	-	96	EXCELLENT
4	VELLANGIRI	25	10032	19.2.12	5.3.12	Male	RTA	F	Left	2b2	# rib	Recon plate	7	12	8		-	-	P	-	-	-	94	EXCELLENT
5	KARTHIKEYAN	32	19867	10.4.12	23.4.12	Male	RTA	F	Right	2b2	Nil	1/3rd tubular plate	5	24	24	-	-	P	-	-	P	-	83	Good
6	VENKETESH	26	24218	11.5.12	16.5.12	Male	RTA	D	Right	2b2	Nil	LCP	5	12	8	-	-	-	P	-	-	-	96	EXCELLENT
7	DEVRAJ	30	24374	13.5.12	21.5.12	Male	RTA	D	Left	2b2	Nil	LCP	5	10	6	-	-	-	-	-	-	-	98	EXCELLENT
8	SUGUNA	29	25554	31.5.12	5.6.12	Female	Acc Fall	F	Left	2b1	Nil	Recon plate	5	10	8	-	-	-	-	-	-	-	94	EXCELLENT
9	PERIYASAMY	42	28672	29.6.12	5.7.12	Male	Acc Fall	F	Left	2b2	Nil	Recon plate	5	14	8	-	-	-	-	-	-	-	96	EXCELLENT
10	KANAKASABAi	22	29764	8.7.12	19.7.12	Male	RTA	D	Left	2b2	Nil	Recon plate	5	12	8	-	-	-	-	-	-	-	96	EXCELLENT
11	SURESH	20	31388	29.7.12	8.8.12	Male	Acc Fall	F	Right	2b1	Nil	Recon plate	5	12	8	-	-	-	-	-	-	-	96	EXCELLENT
12	ILAYARANY	35	34776	7.9.12	13.9.12	Female	Acc Fall	F	Right	2b1	Nil	Recon plate	5	14	10	-	-	-	-	-	-	-	94	EXCELLENT
13	JAGAJEEVANAM	26	43314	5.11.12	8.11.12	Male	RTA	D	Left	2b2	Nil	Recon plate	5	14	10	-	-	-	-	-	-	-	94	EXCELLENT
14	ARIVAZHAKAN	35	43738	9.11.12	19.11.12	Male	RTA	F	Right	2b2	Nil	Recon plate	5	16	12	-	-	-	-	-	-	-	98	EXCELLENT
15	SARAVANAN	23	44872	12.11.12	21.11.12	Male	RTA	D	Left	2b2	Nil	LCP	5	12	8	P	-	-	-	-	-	-	94	EXCELLENT
16	NAGANDRAN	26	45806	19.11.12	1.12.12	Male	RTA	F	Right	2b2	Nil	LCP	5	12	8	-	-	-	-	-	-	-	98	EXCELLENT
17	KANNIYAMMAL	32	46500	24.11.12	30.11.12	Female	Acc Fall	F	Left	2b1	Nil	Recon plate	5	16	12	-	-	-	P	-	-	-	94	EXCELLENT
18	SURESH	20	46882	28.11.12	4.12.12	Male	Acc Fall	F	Left	2b1	Nil	Recon plate	5	8	4	-	-	-	-	-	-	-	98	EXCELLENT
19	NAVEEN	20	49144	15.12.12	18.12.12	Male	RTA	D	Right	2b2	Nil	LCP	5	12	10	-	-	-	-	-	-	-	94	EXCELLENT
20	KUMAR	28	49726	18.12.12	26.12.12	Male	RTA	F	Right	2b2	Nil	LCP	5	12	10	-	-	-	-	-	-	-	96	EXCELLENT
21	PRABHAKARAN	24	1001	7.1.13	12.1.13	Male	RTA	D	Right	2b2	Nil	LCP	5	12	8	-	-	-	-	-	-	-	94	EXCELLENT

22	SIGARAN	40	8312	22.2.13	12.3.13	Male	RTA	D	Right	2b2	Nil	LCP	5	12	10	-	-	-	-	-		-	94	EXCELLENT
23	VELMURUGAN	30	11340	16.3.13	25.3.13	Male	RTA	D	Right	2b2	Nil	Recon plate	5	14	10	-	-	-	-	-	-	-	94	EXCELLENT
24	TAMILPANDIAN	22	12152	22.3.13	29.3.13	Male	RTA	F	Right	2b2	Nil	Recon plate	5	14	10	-	-	-	-	-	-	-	98	EXCELLENT
25	VANNILA	28	16122	19.4.13	2.5.13	Female	RTA	F	Left	2b2	Nil	Recon plate	5	14	10	-	-	-	-	-	-	-	96	EXCELLENT
26	ARUMUGAM	43	19926	19.4.13	20.4.13	Male	RTA	D	Right	2b2	Nil	LCP	5	12	10	-	-	-	-	-	-	-	96	EXCELLENT
27	KUPPUSAMY	20	17030	23.4.13	29.4.13	Male	RTA	F	Right	2b2	Nil	LCP	5	14	10	-	-	-	-	-	-	-	96	EXCELLENT
28	VASANTH	20	17528	3.5.13	6.5.13	Male	RTA	D	Right	2b2	Nil	LCP	5	12	8	-	-	-	-	-	-	-	94	EXCELLENT
29	MANICKAM	51	18600	7.5.13	13.5.13	Male	Acc Fall	F	Right	2b1	Nil	Recon plate	5	16	12	-	-	-	-	-	-	-	94	EXCELLENT
30	VINODHA	30	21066	23.5.13	25.5.13	Female	Acc Fall	F	Right	2b1	Nil	LCP	5	12	10	-	-	-	-	-	-	-	98	EXCELLENT
31	SAKTHIVEL	32	24286	14.6.13	17.6.13	Male	RTA	F	Right	2b2	Nil	Recon plate	5	12	10	-	-	-	-	-	-	-	96	EXCELLENT
32	PERIYANNAN	44	25616	24.6.13	3.7.13	Male	RTA	D	Right	2b2	Nil	Recon plate	5	12	10	-	-	-	-	-	-	-	94	EXCELLENT
33	JAGANNATHAN	21	24896	16.6.13	27.6.13	Male	RTA	F	Right	2b2	Nil	Recon plate	5	12	8	-	-	-	-	-	-	-	94	EXCELLENT
34	KAVIYARASU	20	25692	28.6.13	1.7.13	Male	Acc Fall	F	Right	2b1	Nil	Recon plate	5	12	8								96	EXCELLENT

FOOSH=F= Fall on out stretched hand D = Direct Injury to Shoulder